DOCUMENT RESUME

ED 101 410 CS 500 974

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TITLE	Proximity: Location, Time, and Opportunity to Communicate.
SPONS AGENCY	Office of Naval Research, Washington, D.C.
PUB DATE	Nov 74
NOTE	19p.; Paper presented at the Annual Meeting of the Western Speech Communication Association (Newport Beach, California, November 1974)
EDRS PRICE	MF-$0.76 HC-$1.58 PLUS POSTAGE
DESCRIPTORS	Computer Programs; Higher Education; *Human Relations; *Interpersonal Relationship; Measurement Instruments; *Organizational Communication; *Research Methodology; *Research Tools; Social Relations
IDENTIFIERS	Communication Research; *Proxemics; PROXVAL

ABSTRACT

Traditional measures of proximity all share three common weaknesses: (1) they are based on ratio-level measurement of physical distance that may not correspond to "psychological distance;" (2) they measure distance as a fixed rather than variable quantity; and (3) they measure distance between pairs of individuals rather than larger groups of people. A conceptualization of proximity which attempts to deal with these problems for use in large organizations is developed in this paper. Proximity is defined as the probability of people being in the same location at the same point in time, that is, as an opportunity for face-to-face communication made possible by time and space. It is operationalized as a mean joint probability among all people in the organization. A computer program," PROXVAL, which was developed to calculate the required quantities, is described. Initial attempts at pilot testing the procedure are reported. (Author)

PROXIMITY: LOCATION, TIME, AND OPPORTUNITY TO COMMUNICATE*

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Presented at the Annual Convention
of the Western Speech Communication Association
Newport Beach, California
November 1974

*This research was sponsored by the Organizational Effectiveness Research Programs, Office of Naval Research (Code 452), under Contract No. N00014-73-A-0476-0001; Peter R. Monge, Principal Investigator

ABSTRACT

Traditional measures of proximity all share three common weaknesses: (1) they are based upon ratio-level measurement of physical distance that may not correspond to "psychological distance," (2) they measure distance as a fixed rather than variable quantity, and (3) they measure distance between pairs of individuals rather than larger groups of people. A conceptualization of proximity which attempts to deal with these problems for use in large organizations is developed in this paper. Proximity is defined as the probability of people being in the same location at the same point in time, i.e., as an opportunity for face-to-face communication made possible by time and space. It is operationalized as a mean joint probability among all people in the organization. A computer program, PROXVAL, which was developed to calculate the required quantities, is described. Initial attempts at pilot testing the procedure are reported.

Introduction

A considerable amount of research has been conducted exploring proximity and its relationship to human behavior. It ranges from reports of carefully controlled laboratory experiments (e.g., Argyle and Dean, 1965) and field experiments (e.g., Thayer and Alban, 1972) to observational studies (e.g., Sommer, 1959) and astute descriptions (e.g., Goffman, 1971). It covers interpersonal spacing (e.g., Baxter, 1970), territorial behavior (e.g., Hoppe, Greene, and Kenny, 1972), small group seating arrangements (e.g., Bloom and Winokur, 1972), living patterns within a residence (Smith, et al., 1969), and interpersonal linkages within communities (Merton, 1950) and across the United States (Travers and Milgram, 1969).

The relationship between proximity and communication has also been clearly established. Several studies have demonstrated that the amount of communication varies inversely with the distance between the communicators. For example, Gullahorn (1952) found that the distance between work locations of clerical personnel configured their communication patterns so that the greater the distance between two workers, the less they communicated. Adams (1959) also related distance to communication when his analysis of classroom participation among elementary and secondary students revealed that ". . .communication was heavily concentrated in the center front of the room and--with ever-diminishing force--in a line directly up the center of the room."

It has also been established that there are different types of spatial relationships to be considered. As conceptualized by Hall (1966), there are three types of space to be recognized with respect to human interaction. The first he calls informal space, which designates an area which extends outward from each individual to the extent of his unaided senses, and, therefore, shifts with the mobility of that individual. The second he terms fixed-feature space, since it is defined by permanent objects such as walls. And the third is semi-fixed-feature space, which is configured by movable objects such as furniture.

Informal space (most frequently referred to as "personal space", e.g., Sommer, 1969) has been examined extensively in attempts to establish its shape and size (e.g., Schneiderman and Ewens, 1971; Pedersen, 1973), to specify its use (e.g., Mehrabian, 1968), and to determine such influences as the impact of the sexual composition of the dyad (e.g., Watson and Graves, 1966; Little, 1968), age (e.g., Jones and Aiello, 1973; Willis, 1966), and personality (e.g., Cook, 1970; Smith, 1954), to name but a few.

Semi-fixed-feature space has been studied in a variety of ways, including the impact of various fixed seating arrangements upon communication (e.g., Mehrabian and Diamond, 1971), the impact of a position within fixed seating arrangements (Schwebel and Cherlin, 1972), and the impact of positive and negative interactions upon selection of spatial arrangements for dyadic living conditions (Altman and Haythorne, 1967).

Fixed-feature space has been investigated with respect to the arrangement of apartments and houses within a complex in terms of friendship choices (e.g., Festinger, Schachter, and Back, 1950), the impact of different floors within a large living facility upon friendship (e.g., Yarosz and Bradley, 1963; Bonney, Hoblit, and Dryer, 1953), and the amount of visiting within or outside a neighborhood (e.g., Lee, 1973).

Although these different conceptualizations of space have proved valuable in the study of proximity, they have traditionally been operationalized in terms of "physical distance". There are, we believe, three weaknesses with these distance measures of proximity.

First, physical distance is a continuous measure which extends to infinity, whereas psychological or perceptual distance, which operates in face-to-face communication, is a bounded phenomenon which is subject to the configurations of semi-fixed and fixed-feature space. Whenever a significant boundary occurs, some form of interposed (non face-to-face) interaction must be utilized or communication cannot occur. Further, physical distance implies a continuous ratio level measurement, that is, twenty feet is twice the distance of ten feet and forty is twice twenty. The problem occurs when two people perceive the distance between themselves and the other as much different than is actually the case. For example, two people sitting five feet from each other in adjacent rooms (separated by a wall partition) will consider themselves much farther apart than they are to other people in their respective rooms who are considerably farther away (say up to twenty feet) but within their visual range. Further, though distance between two people may continue to increase, face-to-face communication is limited by a maximum distance of 20-24 feet (Hall, 1959) or some similar small distance.

Secondly, traditional distance measures of proximity tend to fix people in space. As yet, little work has been undertaken to measure the changes in distance that occur as people behave through time. People rarely keep themselves at a fixed distance from one another.

Finally, proximity has typically been studied as a distance between pairs of individuals. But in many social settings, people are located in proximity to multiple others. It seems plausible that a person's proximity to another is contingent upon his perceived proximity to others in his relevant environment. Proximity should be studied, then, in such a way that permits a person to be located in relationship to these other relevant individuals.

The purpose of this paper is to develop a conceptualization of proximity that will meet these three objections that we have raised to traditional measurement techniques and to report the first findings from our attempt to empirically test such an approach.

Conceptual and Operational Considerations

Although most empirical studies involving proximity have circumvented the consideration of time, it is too essential an element to be ignored. In his Man, Time and Society, Moore (1963) suggests that since social activity often requires synchronization, sequencing, and frequency (or rate), "modern industrial societies are time oriented--not task oriented." In addition, he states that "time. . .becomes, along with space, a way of locating human behavior; a mode of fixing the action that is particularly appropriate to the circumstances (p. 7)." Likewise, Harrison (1965) argues that there are four major areas of non-verbal communication: time, space, action, and object, which he related by observing that "Time and space provide the major dimensions. Actions occur in time and objects occur in space. Actions and objects are related since actions occur through the movements of objects (p. 165)." Movement, of course, is defined in terms of time and space.

It is of interest that nearly all published studies have focused upon proximity without consideration for any time factor. This circumvention of the time element usually occurs because studies are designed to measure variables at a single rather than at multiple points in time, thereby making the dynamic event a static one. The choice of a single measurement point is not always inappropriate and may be warranted by the focus of the study. However, proximity is a much more dynamic relationship than the majority of experimental and field study designs would indicate.

Consider the studies on interpersonal distance. If we are interested in how individuals use space, are we not interested in how it is employed over a period of time? Frequently, however, studies specify a particular point at which measurement is made; no others are utilized to provide an indication of how proximity may fluctuate during an interpersonal encounter. Examples of the selection of a single time point include: (a) when the subject specifies an approach distance as "comfortable" (e.g., Edwards, 1972); (b) when the subject performs some predetermined act such as initiating conversation (Willis, 1966) or passes a specified point (Baxter, 1970) or positions his chair (e.g., Kleck, et al., 1968); and (d) when the subjects are fixed by still photography (Thomas, 1973). All fix the dynamic use of space by taking the measurement at a single time point.

Frequently, when measurements are actually taken over time, the proximity is fixed by designation (e.g., Conrath, 1973, measured all distances from the employee's work station) or by design (e.g., Porter, Argyle, and Salter, 1970, had subjects sit in fixed chairs). Although the measurements were temporal, proximity was arranged to prevent the dynamic changes in position encountered in everyday experiences.

On occasion, proximity has been observed in flux. The measurement has been discrete, however, rather than continuous. For example, Altman and Haythorne (1967), Esser, et al., (1965), and Gullahorn (1952) used spot-check observations, and King (1966) used stop-action photography. Discrete measurement of continuous events risks the loss of important data. However, if the interval between measurements is minimized sufficiently, this may not prove critical, as with King, who utilized a ten-second interval. Video recording devices are probably best suited for this type of continuous measurement, but such methods are frequently too expensive for long periods of time or for large areas of coverage especially in terms of the time and effort involved in coding video data for analysis.[1]

A second consideration is the type of measurement utilized in studying proximity. Linear measurement (straight line distance) encounters difficulties due to the configuration of the environment. When a proximity study only involves informal space, it is appropriate to use a linear measure. However, when direct distance is a line which passes through the boundaries of fixed-featured space, "true" proximity is a property of the spatial configuration, and this must be considered. This configuration, dictated by the fixed features, is the usable or "functional" space. Functional space has been considered in a number of studies. It is handled by modifying the linear measurement values obtained. For example, Festinger, Schachter and Back (1950) considered such factors as the location of stairways and the orientation of the front door of

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1 Herron and Frobish (1969) describe computer software designed for the analysis and display of movement patterns obtained by overhead filming and Haith (1966) describes an ingenious set of hardware designed for the key-punching of co-ordinate data onto IBM cards via a grid situated over the projection of each video frame.

each dwelling, and Conrath (1973) used a weighting factor of zero or one to compensate for "inconvenience".

Unfortunately, there is little to guide the researcher in how to evaluate differences created by functional aspects of the environment. In his study of distances between residences and choice of spouse, Thomsen (1969) used a linear distance measure but suggests it is more reasonable to calculate proximity in terms of "transportation time" (the amount of time required to traverse the distance between the two points). Transportation time represents a more realistic measure than distance, if one considers proximity in terms of ease of contact. Certainly within a city, equal distances are not necessarily equal in time travel; for example, one may be more likely to travel to point X which is ten minutes away than to point Y which is 20 minutes away, even if the surface mileage is the same.

An Alternative Measure of Proximity

Our interest in proximity is based upon an interest in developing a measure applicable to the study of communication within large, complex organizations. Therefore, although the studies concerning the dynamic use of space during interpersonal interactions supported the relationship of proximity to communication, it was the studies involving the impact of residential proximity upon friendship patterns which seemed most applicable to our needs. The nature of this relationship appears to be best conceptualized by Berscheid and Walster (1969) who, after a review of some of the literature on propinquity, ask, "What underlies the often obtained relationship between proximity and sentiment? Obviously something is made possible, or more likely, with decreasing distance. It seems apparent that what is made possible is an increased probability of receiving rewards or punishments from the other (page 49)." The key to their analysis is that proximity represents an opportunity for communication--that a decrease in distance leads to an increase in the probability of communication.

The operationalization of proximity as an opportunity or probability rather than as a distance concept appears to be an innovative approach to its study. For the purpose of this study, proximity has been conceptualized as the probability of people being in the same location at the same point in time. Specifically, each building which comprised the organization was designated as a basic unit of location and data were collected on the number of hours each individual spent in each location. The conversion of reported hours to percentage of the work week (operationalized as a fifty-hour, five-day week) yielded the probability for a given individual to be in that building at a given time. The joint probability of two persons being in the same building at the same time was then calculated. This was accomplished by multiplying the individual probabilities together since the joint probability of any two independent events is the product of the separate probabilities of each event. By summing the joint probabilities of a given pair occupying each of the buildings, the total joint probability of their being in the same location at the same time was computed for the total week. For each individual a value was thus obtained representing his proximity to each other individual. The mean of these joint probability values yielded a single value representative of his proximity to all others. Neither linear distance nor "time to traverse" distance is required when utilizing a time-base probability measure of proximity since it assumes that the individuals are physically close enough.

The advantage of this approach to proximity is to be found in calculating for each individual a single value which represents that person's position with respect to all other individuals during a standard time frame. As with every representation of reality, it is important to keep in mind the underlying assumptions. In the case of using an average joint probability calculation, there are at least two such considerations.

First, the calculation of the basic joint probability values (one individual's opportunity for communication with any one other individual by virtue of being in the same location) assumes independent events. That is, it is assumed that the presence of one individual in a location is independent of another, so that the probability of the one being there in no way affects the presence or absence of the other. Although it is easy to envision that an individual spends two hours per week in location X because another individual is there. We must remember that the final value calculated represents the individual's relationship to all other individuals. In most cases the absence of a single individual does not effect the time which other members spend in specific locations. Hence, we feel that it is best to treat all the events as independent, remembering that the patterns of some pairs of individuals may in fact be dependent.

Secondly, a like problem arises from the underlying assumption that joint probability involves randomness. This would mean that if an individual reports that he spends twenty hours per week in location X, these hours will randomly vary throughout all the possible hour combinations of a work week. Like the problem of dependence, this varies with the nature of the work. Unlike the problem of dependence, however, most rather than few, relationships violate this assumption. People seem to be creatures of habit.

In the present study, we selected the building as the basic unit of space. Although this provided 36 locations for which the subjects reported data, the selection of the building as the basic unit of data collection did not represent the optimum unit since the measurement technique assumes that the individuals as physically close enough for communication. Hence the unit should correspond to the fixed-featured space of the facility so the impact of fixed features is circumvented. Future testing will correct for this problem.

To handle the vast quantity of calculations required to compute a mean joint probability value for a large number of persons and locations, a computer program, named PROXVAL, was developed. Originally written in JOVIAL for compilation and execution on a CDC 3300 computer, it was subsequently modified and coded in FORTRAN for running on an IBM 360/67. Both versions calculate a mean joint proximity value for up to 500 persons based upon the amount of time spent in up to 36 locations. In addition, the FORTRAN version is designed to output the joint probability value for every pair of subjects and can be requested to calculate values for only a subset of the total population.

Pilot Test of the Measure

Our rationale in undertaking the initial pilot test was to ascertain whether well-documented results could be replicated under the present alternative conceptualization of proximity in a large organizational field setting. Thus, the two well-known hypotheses put to the test were:

H_1: The greater the potential for communication provided by physical proximity, the greater the amount of actual communication.

H_2: The greater the potential for communication provided by physical proximity, the greater the interpersonal liking of the proximate individual.

Data reported in this paper were obtained as part of a larger study designed to identify the determinants of communication structure in a large organization (see Monge, Kirste, and Edwards, 1974). Data were collected from 458 subjects (Ss) at a midwestern naval training center. All staff personnel, except those on leave or absent due to illness, were included in the study. In addition to proximity, the variables included three dimensions of job, demographic characteristics of the personnel, their satisfaction, and the degree to which they liked or disliked their co-workers. The communication network itself was measured by analyzing data collected on who communicated with whom, the amount of that communication, and the importance of that communication. Specifically, the communication data were obtained by a questionnaire which asked Ss to search a list of all permanent employees of the base and to indicate the persons with which they communicated during the "average" week and the "typical" amount of time in number of hours and minutes. Communication included all oral and written interactions and the "average" work week was specified in terms of specific days and times to eliminate problems of different shifts; it comprised a 50-hour week to include lunches and some pre- or post-shift contacts. In addition, Ss were requested to use a seven-point scale to indicate the degree to which they liked or disliked each individual they specified under the communication category.

In order to obtain the data on proximity, Ss were provided with a map of the base which showed each building. Ss were requested to locate all buildings in which they spent time (during the same "average" week) and to indicate the number of hours per week next to the appropriate building number. Two additional categories ("out-of-doors" and "elsewhere") permitted responses which involved time not within one of the structures or off the base.

In order to test the research hypotheses, 75 Ss were randomly selected from the population (458 persons). Since not everyone communicates with everyone else, actual data pairs for the study were limited to individuals within the random sample who specified communication and attraction values for at least one other in the sample. Data on the number of minutes per week they communicated, the attraction value they assigned, and the proximity value for the pair were obtained. To eliminate problems of utilizing both reciprocated and unreciprocated contacts in correlation to proximity for each pair, the data were stored in a square, subject by subject matrix; only the upper triangle was utilized, however, representing an arbitrary but unbiased method of selecting only one of each pair's report on communication and attraction. This method resulted in data for 125 communication relationships for correlation with the proximity and attraction variables.

Proximity values were calculated by utilizing PROXVAL (described earlier), which provided a joint probability value for each pair across all buildings as well as the mean joint probability value for each individual. The appropriate product moment correlations were calculated using the Statistical Package for the Social Sciences, Version 5.2.

The results are shown in Table One. The obtained correlations among variable pairs testing the two hypotheses were non-significant ($df=124, \alpha=.05, r \approx .14$, see Edwards, 1968, p. 420). Furthermore, they were so low as to account

	Amount of Communication	Proximity	Attraction
Amount of Comm.	1.00	.11	.10
Proximity		1.00	.05
Attraction			1.00

Table 1. Correlation coefficients among Amount of Communication, proximity, and Attraction.

for approximately one percent of the variance. The third correlation in the table is reported in order to demonstrate that the low obtained values among the primary relationships are not attributable to attenuating effects of the relationship between proximity and attraction. The partial r between amount of communication (1) and proximity (2), controlling for proximity, $r_{12.3}=.10$; between amount of communication and attraction, controlling for proximity, $r_{13.2}=.09$.

Discussion

We would offer two reasons to account for the failure to replicate the two well-known findings. First, it is quite possible that the measure of communication utilized was too global. Conrath (1973) found that the distance between individual work locations was inversely correlated to the amount of face-to-face and written communication but was uncorrelated to the amount of telephone communication. Since our data collection technique ignored specific channels utilized, it seems likely that inclusion of separate questions for the telephone and other modes of communication would substantially increase the correlation between proximity and amount of communication.

Second, it is quite likely that failure to obtain significant results can be attributable to the "level of resolution" of the location measures. Location, it will be recalled, was defined as one of 36 buildings on the base. Had a more refined measure been utilized, (e.g., floors in the building, or rooms on the floors) the obtained relationship might have been much stronger. This argument is particularly compelling if one considers the earlier discussion of the importance of making the unit of location for which proximity is calculated congruent with fixed-feature space. Using the building as the unit of measure obviously fails to account for this problem since being in the same building does not necessarily mean sharing a location appropriate for communication.

We remain convinced that despite the failure to replicate the two well-known findings, that the conceptualization and operationalization of proximity developed in this paper has merit. We would invite researchers interested in studying proximity in large organizations to join us in testing and refining the approach we have described.

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